

EDITORIAL ARTICLES.

ON STENOSIS OF THE TRACHEA AFTER TRACHEOTOMY FOR CROUP AND DIPHTHERIA.

The difficulties and dangers, experienced in so many cases, on attempting, after the primary disease has subsided, a removal of the canula from the trachea, in which it has remained for some time, are well known to many. These have recently been considered in a series of papers published in the *Deutsche Medicinische Wochenschrift*, 1885, by Dr. Wilhelm Fleiner of Heidelberg. Chief among these are the sudden attacks of asphyxia, etc., which occur at this period. Fleiner regards these as caused by a contraction of the lumen of the trachea, appearing under certain conditions after tracheotomy in cases of diphtheria. Until 1884, the literature on this subject contained but some 50 cases of stenosis of the trachea after tracheotomy, and these with 6 cases coming under the personal observation of the author, in the Heidelberg clinic, together with 15 cases recently reported by Mensel, Hupeden, Parker, Passavant and others, form the total number, from which conclusions may be drawn. A reliable percentage of cases of tracheotomy with or without stenosis is, owing to the conflicting reports and differences of opinion, hardly possible. B. Lindner reports 103 cases of tracheotomy, 38 with recovery, among which were 3 with stenosis. Simon had one case of stenosis in 12 cases of tracheotomy, and Krönlein one case of stenosis out of 65 cases of recovery. Of the 103 cases of tracheotomy performed in Heidelberg from January 1877 to July 1880 (surgical clinic), 57 recovered, and among the latter number were 4 with stenosis. The author, in describing the condition of the mucous membrane of the trachea at the period when the diphtheritic process is healing, calls attention to the constant state of irritation to which the wound is subjected by the presence of the canula,

acting as a foreign body, and also to the infection to which it is exposed by direct contact with the diseased tracheal membrane. The canula exerts considerable pressure on the cartilage of the trachea, which, being elastic, has the constant tendency to resume its natural shape. But this being prevented by the presence of the canula, a bulging of the lining on the posterior wall of the trachea takes place, (Carié). This bulging fold is crescent-shaped (Passavant) and protrudes into the lumen of the trachea, more or less, according to the size of the canula. It disappears in most cases after the canula has been removed. There is, however, a tendency to infiltration and new-tissue-formation about the edges of the wound, if the canula be retained too long, resulting in fixation of the cartilage rings in this position and causing this bulging of the posterior membranous wall to remain.

Dangerous obstructions to breathing may be also caused by the proliferation of granulation-tissue on surfaces denuded by diphtheritic ulcerations, etc., so-called granulation-stenosis. Fleiner illustrates this by the history of an interesting case, where sudden death was caused by such obstructions. The submucous interstitial tissue in the upper portion of the trachea, near the vocal cleft, being less firm in its construction than that lower down, inflammatory infiltration takes place more easily; whence the greater danger of cricotomy and superior tracheotomy. Whether or not the cartilage of the trachea is directly affected by the diphtheritic process, has not as yet been determined, but the author considers that the strictures, so often observed after epidemics, would indicate a certain loss of elasticity in the cartilage, rendering it less able to withstand cicatricial retraction. This seems to be the opinion also of Neudörfer, who was the first to call attention to a shrinkage of the cartilage. Demme is of the same opinion. Be this as it may, it is certain that a flattening of the trachea anteriorly may follow a withdrawal of the canula, especially if the incision has been made too large, and chiefly when the patient is reclining on his back, (Passavant). In this position, namely, the trachea is elongated, and the anterior wall being much stretched, it yields more easily at the place of incision, where less resistance is offered.

Stenosis may be caused also by hyperplasia of the cartilage, as observed by Gerhardt and Heine, the latter in the form of "concentric hyperchondrosis" in cases of syphilis. It is probable, however, that in certain cases, simple thickening of submucous tissue has been mistaken for hyperplasia of the cartilage. The author found but one case of the latter mentioned. The trachea was 7 mm. in thickness, its lumen being so small that only a female catheter of 5 mm. diameter could be introduced. It is important to know that stenosis of the trachea may be furthermore brought about through the false position of the cartilage-rings, severed in tracheotomy. If, namely, the incision be too small for the canula, the edges of the cartilage-rings will be bent inwards, when this is introduced. If the canula be not soon removed, the edges will be retained in this position, owing to inflammatory infiltration. In some cases the elasticity of the cartilage may correct this, but in most cases we find the ends, often denuded of membranous covering, pointing inwards into the lumen of the trachea.

Strictures of this kind are often complicated and made worse by the presence of the membranous fold on the posterior wall alluded to above. In a case of the author's the stenosis was of this kind and so great that inferior tracheotomy was necessary. It will be seen, therefore, that the canula plays a large part in the production of stenosis.

Acting as a foreign body, it not only causes a permanent state of irritation, but this may be greatly increased when the canula does not fit properly, is badly constructed, with sharp lower edges, incorrect curvature, etc., all of which cause lesions in the walls of the trachea, and eventually decubitus. Fleiner says the usual points of decubitus are : (1) On the posterior wall, corresponding to the greatest convexity of canula ; (2) on the anterior wall, corresponding to the end of the canula ; (3) on the posterior wall, also corresponding to the end of the canula, when the latter is too short. Such decubitus heal readily if early enough detected, and properly fitting canulas be used. Völker says of Trousseau's canulas, that they are constant causes of granulation-stenosis by their uneven pressure on the trachea walls. The upper inner, and lower outer angles of the tracheal wound are usually free from pressure, and on these places granulations often develop to great size.

Trousseau, Millard and Barthez recommended frequent and early changing of the canula, in order to accustom the patient as soon as possible to dispense with its use. An interesting case, showing the importance of this procedure, is given by Bouchut. Pat., boy, æt. 13, had undergone tracheotomy for croup, six years before, and had always worn a canula since then, as he could not bear its removal on account of violent dyspnœa, as soon as this was attempted. The canula used, however, was the smallest number made, too small to serve for the purpose of respiration. Patient breathed freely through his mouth, spoke loud and clearly. Canula acted simply as a foreign body in the trachea, pressing down by its curvature and weight, a mass of granulations on the mucous membrane below the fistula. Without this pressure, this mass rose up and obstructed respiration more than the canula did. In this case and in one of Uhde, where the canula was worn for forty years, the cause of stenosis would not support the theory of Pauly and Völker, who maintain that continued use of the canula caused stenosis in their cases.

The author believes that the continued use of a canula is caused, in many cases, by a stenosis of the trachea, and not the stenosis by the long use by the canula. Trousseau's rule, namely, that the sooner the canula is removed, the better the result, may be in general a good one to follow. Still, in some cases, this may not only be detrimental, but even dangerous. On the whole, it will be found advisable to remove the canula only then, when the patient is able to breathe past the closed canula, and to breathe and speak freely through the window. This is generally between the fifth and ninth day, often, however, later.

It will be seen then, to recapitulate, that stenosis may arise from: (1.) granulating wound surfaces. (2.) swelling etc. of the mucous membrane, (3.) loss of elasticity in the cartilaginous walls, (4.) displacement of the divided cartilage rings.

These exuberances of granulation tissue are found mostly at the place of the tracheal wound, sometimes, however, lower down in the trachea, at a point corresponding to the lower end of the canula. They are of different form, some being bulb-shaped, others curtainlike with a granulating, rough surface. They often become œdematous, forming a ver-

itable vesicle obstructing respiration. They appear singly and in masses, and differ much in size. Koch observed in one case five granulomata. Complete closure of the trachea may result from the union of two granulomata, lying opposite each other. Cases of this kind are reported by Steiner, Weber and Roux. Cicatricial retractions of the mucous membrane of the trachea, causing strictures, have nothing especially characteristic, but resemble closely those of other canals. A stenosis of the trachea may also follow retraction of extratracheal cicatrices, acting on the cartilage and compressing the trachea, (Simon). The symptoms which arise on removing the canula when stenosis is present, are modified more or less, according to the seat and nature of the latter. The worst and most alarming symptoms are observed in cases of stenosis caused by loosely suspended granulations. Under certain nervous conditions which affect the circulatory system, these granulomata alter very much in size. Numerous cases, recorded in the literature on this subject, in which sudden mental disturbances, such as fear, anger, etc., have lead quickly to asphyxia and death, show that these granulomata became enlarged through an increased circulatory condition, owing to these psychical influences. Such cases were observed by Gigon, Calvet, Bouchut, Krishaber, Pauly, Bose and others.

These granulomata, when the canula is removed, fluctuate during respiration, and often become lodged in the larynx, causing complete or partial obstruction to breathing. The author considers this a more plausible explanation for those sudden attacks of asphyxia on attempting to remove the canula, than that based on a vaso-motory change in the granuloma through psychical influences, although he does not deny that the latter are often the cause. In many cases, when the removal of the canula has been followed by these attacks of dyspnœa etc., the effect on the patient is such that he strenuously resists all similar attempts. In nervous and irritable children, even where no objective symptoms exist, according to Sanné, a certain spasmodic condition, dependant on the fear of suffocation, hinders the removal of the canula. Sanné, Millard and Schmidt record cases of this kind. In a number of cases these alarming symptoms appear much later, at irregular periods, oftentimes months after the removal of the canula. Their sudden ap-

pearance may be due to increased respiration after violent physical exertions, psychical excitements, etc., and may be furthermore favored by catarrh of the air passages. Regarding a diagnosis as to the seat of the stenosis, much might be said. This may be sometimes localized by the maximal intensity of the stenosis—murmur heard all along the trachea. At other times the depression of the soft parts during inspiration, or an asymmetry or deformity of the trachea, gives the clue. In some cases, owing to the absence of objective conditions, it may be questionable whether the trachea or larynx is the seat of stenosis. In the latter case, the voice is changed or quite absent. Trélat calls attention to the fact that in stenosis of the larynx, phonation is first altered, whereas in stenosis of the trachea, respiration is first affected. Owing to the fact that the patients are mostly young children, a laryngoscopic examination is hardly possible. A thorough inspection of the cause of the stenosis will be advisable as soon the latter has been localized. Strictures of the trachea have not the treacherous character of the granulation stenosis, since, owing to their slow development, the organism may accustom itself gradually to their presence, and severe and alarming symptoms only appear when the lumen of the trachea has become much reduced in size.

The plan of treatment will depend largely on the possibility of making a diagnosis of the existence, seat and character of a stenosis. Granulations may be removed by excision, caustic means, etc. Great care should be exercised in using the latter. In order to prevent recurrence, a continued use of caustica will be advisable, or mild adstringentia inhaled or insufflated in powder form. Fleiner gives the history of a case in which Paquelin's thermocautery was used with complete success in the removal of these granulations. When cicatricial retraction is present with a stenosis, dilatation of the narrowed part will be indicated. This is best accomplished in a gradual manner by means of bougies, etc., introduced either through the mouth or the fistulous opening in the trachea. Such bougies as those of Dupin's and Roser's larynx dilator, are the best, as these allow enough space for respiration while lying in the trachea. When the trachea has been dilated to about its normal size, the aim of further treatment should be to maintain this and to pre-

vent the recurrence to which all artificially dilated parts are prone for a long time. Trousseau and Dupins have both constructed canulas for this latter purpose. The high degree of sensibility of the mucous surface of the larynx and trachea, renders all attempts at dilatation through the fistula almost impossible without narcosis. This is also often the case when undertaken through the mouth. Strictures situated below the fistula are more easily treated through this latter opening, than those lying above it, as dilating instruments are more easily introduced. For the treatment of a stenosis lying far below the tracheal opening, and which results mostly from decubitus, there are a number of specified instruments. The existence of such a decubitus may be early detected by the bloody sputum, cough, fetid breath, etc. and should be treated prophylactically. This is best accomplished by a changing of the canula. The fresh canula should be either longer, reaching beyond the affected spot, or shorter than the old one. If another canula be not attainable, a piece of rubber tubing drawn over the end of the old canula, will accomplish this purpose. The double canula of Robert is particularly efficient in such cases of deep lying stenosis. Similar ones have been constructed by Gendron, Trousseau and Demarquay. If, however, no satisfactory result be attained by this mode of treatment, or if the stenosis show the tendency of returning, an operative interference is certainly indicated. Division of cicatricial bands, as in internal urethrotomy, will be necessary in most cases on beginning a treatment of simple dilation, if this is to be successful. Operative treatment would consist in external incision of the trachea analogous to that employed in strictures of the urethra. Simon was the first to undertake this mode of treatment in 1868. He divided the trachea at the point of stenosis, downwards, and the larynx upwards to the middle of the thyroid cartilage, introduced the canula in the lower angle of the wound, and attempted, after the internal and external cicatricial bands had been severed, to obtain by suturing union of the mucous membrane of the trachea with the cutis. The result was but a temporary one. Schuller and Bruns favor this external incision, especially in stenosis of the larynx. After the stenosis has been divided it will be found useful to introduce Passavant's T shaped canula.

One great advantage in this method of treatment lies in the possibility afforded of making a thorough examination of the anatomical conditions present. Wegner and Heine have operated in cases of stenosis of the larynx with success. In some cases inferior tracheotomy is said to have had a beneficial effect on a granulation stenosis lying higher up. This is, perhaps, explainable by the fact that the diversion of the air current through the canula may cause a shrinkage of the granulations, the latter being no longer subjected to the irritation of the air-current and increased inspiratory movement. In a case of the author's, however, this desirable effect was not produced. As this operative treatment is, in some children, a matter of serious consideration, the author has constructed an instrument, the use of which was to render the former unnecessary. It may be applied as soon as a stenosis in the neighborhood of the fistula, has been diagnosticated, and which will not yield to simple treatment by caustica, etc. This instrument resembles in its form and size the T shaped canula of Dupins, and is made of metal. To enable its introduction through the fistula, it is composed of three separate parts which are held together by a screw. These three parts are grooved, and when placed together form the tube. By means of the screw the tube lying in the trachea is gradually enlarged until the definite width of the trachea is reached. Fleiner has only used his instrument in three cases, and with but partial success. He recommends furthermore in such cases, Passavant's three part canula.

In conclusion, the author considers at length the question as to whether and how far we are able to prevent by prophylaxis, the development of a stenosis after tracheotomy. As long as we are not able, he says, to control diphtheria, we are powerless to prevent the development of a stenosis arising from diphtheritic ulcerations. On the contrary, however, we have seen that under certain conditions, tracheotomy may be the cause, later on, of a stenosis, and it is very important to recognize these conditions and to avoid them. As the greater number of stenoses arise in the region of the cricoid cartilage, the author advises strongly against incising this. Great care should be taken in the selection of the canula. This should always have a window on the convex side, placed so that its central point lies in the

long axis of the lumen of the trachea. The exact diameter of this latter should be taken at the height of incision before introducing the canula. In this manner the proper size of the canula can be determined, and the irritation to the mucous membrane, caused by ill-fitting instruments, avoided.

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ON THE PRESENT STATE OF KNOWLEDGE IN BACTERIAL SCIENCE AND ITS SURGICAL RELATIONS.

MICRO-ORGANISMS AND SUPPURATION.

Since the chapter on suppuration in general (page 150 of this volume) was written, a most valuable contribution to the questions there considered has come to hand, being a prize-essay furnished by George Klemperer, an undergraduate clinical student of the Berlin University, and published in the *Zeitschrift für klinische Medicin*.¹ The prize had been offered by the faculty in the hope of obtaining some further knowledge leading toward the definite solution of the vexed questions as to the relation of micro-organisms to suppuration, and the contribution under consideration may unhesitatingly lay claim to have elucidated some of the most important points of interest in these questions.

Under the heading above referred to it was concluded from the experimental evidence (Passet), that larger quantities of chemical irritants could produce suppuration even when no bacteria were present; though Scheuerlen had proved that minute quantities (four drops) did not do so. In the present aspect of the subject, however, we are justified in declaring that there can be no suppuration whatever without micro-organisms.

Klemperer considered the precautions taken by previous experimenters (Uskoff, Orthmann, Councilman, Passet,) to prevent the entrance of germs into the tissue-cavity containing the injected chemical substance, to be uncertain and inadequate. He, therefore, adopted a method formerly used by Straus, of Paris, in 1883, consisting in the

¹ Die Beziehung der Micro-organismen zur Eiterung. Gekrönte Preisarbeit. Vol. X. Pp. 158-187.